

A NEW SPECIES OF NET-WINGED MIDGE OF THE GENUS
BLEPHARICERA MACQUART (DIPTERA: BLEPHARICERIDAE) FROM
THE CUMBERLAND PLATEAU OF TENNESSEE

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Abstract.—*Blepharicera courtneyi* Curler and Moulton, new species, is described and illustrated from larvae, pupae, and adults taken from several localities on the Cumberland Plateau of eastern Tennessee. This new species belongs to the *Blepharicera tenuipes* group and shares a number of similarities with *Blepharicera tenuipes* (Walker) and *B. hispida* Courtney. It can be separated from these species by unique combinations of larval and adult characteristics. This is the first record for the family from the Middle Cumberland Plateau Physiographic Region, an area well known for its rugged topography and spectacular, albeit seasonal, whitewater rivers.

Key Words: Diptera, Blephariceridae, net-winged midge, taxonomy, United States

Blepharicera Macquart is one of the most widespread genera of net-winged midges and is the only blepharicerid genus found in both the eastern and western portions of the Nearctic Region. All eastern Nearctic species belong to the *Blepharicera tenuipes* group, a presumably monophyletic assemblage comprised of 16 described species (Hogue 1978, 1987; Hogue and Georgian 1986; Courtney 2000). In March 2006, we collected larvae of two species of *Blepharicera* at two localities on the Cumberland Plateau of east-central Tennessee, *B. capitata* Loew from the Sequatchie River in Cumberland County and an undescribed species similar to *B. hispida* Courtney and *B. tenuipes* (Walker) from the Piney River in Rhea County. Subsequent expeditions to Piney River and additional localities on the Cumberland Plateau yielded additional material of only the latter species, which is described below.

MATERIALS AND METHODS

Study Area.—Sampling areas included several fast-flowing streams on the Cumberland Plateau near Crossville, Tennessee. Piney River drains a portion of the Plateau known as Walden's Ridge. It rises near the Rhea-Bledsoe County line and is referred to in its upper reaches as Piney Creek. Its major tributary, Little Piney Creek, flows over two spectacular but largely inaccessible waterfalls near the community of Grandview. The confluence of the two streams occurs below the falls of the smaller stream in an area referred to as "Shut-in Gap," which we designate as the type locality. Mammys Creek is a major tributary of Piney Creek before the Bumbee Creek confluence. Caney Fork River rises in Cumberland County about 10 km WNW of Crossville and descends off of the Cumberland Plateau through a deep, steep gorge in a remote area known as Scott's Gulf.

Cane Creek flows northwest from its headwaters in southwestern Bledsoe County towards its confluence with the Caney Fork River. A significant waterfall on Cane Creek is located inside the boundary of Fall Creek Falls State Park.

Material.—All specimens were collected between February and May 2006 by benthic sampling, sweeping, and black light. Pupa-adult associations were made using the ontogenetic method (Hogue and Bedoya-Ortiz 1989) or by rearing pupae to emergence (Courtney 1998).

Specimen preparation.—Field-collected specimens preserved in 70 or 95% EtOH. Morphological studies were based on slide-mounted specimens. Slides of larvae were prepared using cedarwood oil to clear specimens and Canada balsam as a mounting medium. Slides of adult structures were prepared using 85% lactic acid, 10% NaOH, or cedarwood oil to clear specimens and Canada balsam as a mounting medium. Specimens were examined using a Meiji Techno RZ stereomicroscope and Nikon E800 and Nikon Optiphot compound microscopes, the former two fitted with optical micrometers. Drawings were rendered with the aid of a drawing tube on the Nikon Optiphot system. The photomicrograph of pupal microsculpture is a composite of images captured using a SPOT RT® Color digital camera and Adobe Photoshop® 7.0. Composite images were created using Helicon Focus®.

Terminology.—Terminology follows Hogue (1978) and Courtney (2000).

Descriptive format.—Diagnoses are provided for all stages. Complete descriptions of the adult female, pupa and larval instar IV and a partial description of the adult male (head and terminalia) are provided. When applicable, sample sizes are provided before each description with measurements in millimeters presented as a mean followed by a range in parentheses. Adult head width was

measured at the point of greatest width of the eyes. Palpal segment ratios were computed as proportions, considering the basal palpomere as 1. Wing length and width were measured at the points of greatest length and width, respectively. Measurements were not taken for pharate adults. Unless otherwise noted, larval characters refer to instar IV. Larval cranial width was measured as the distance between the antennae. Total length of larvae was measured from the anterior-most point of the head capsule to the posterior-most point of the anal division. Abbreviations for life stages: L = larva; P = pupa; A = adult. Abbreviations for type and voucher repositories: USNM = National Museum of Natural History, Smithsonian Institution; UTK = University of Tennessee Insect Museum.

***Blepharicera courtneyi* Curler and
Moulton, new species**
(Figs. 1–8)

Diagnosis.—A medium-sized *Blepharicera*. *Larva*: Dorsum of cephalic division (= cephalothorax) and abdominal segments II–VI each with 4 loosely arranged transverse clusters of fustiform dorsal secondary sensilla. *Pupa*: Integument of abdominal tergites shiny, dark brown; lamellae of respiratory organ of subequal width, broadly pointed apically; anal tergite never wrinkled. *Adult male*: Dorsal eye division much smaller than ventral; cercus with inner margin straight, posterolateral margin slightly extended into rounded lobe, and outer margin cleft; apex of dorsal paramere slightly emarginate on either side of medial dorsal carina; lateral parameral lobe elongate, twice as long (measured from distance of apex to base of ejaculatory apodeme) as median width; apex of ventral paramere extended beyond apical margin of dorsal paramere. *Adult female*: 3 ovoid spermathecae with uni-

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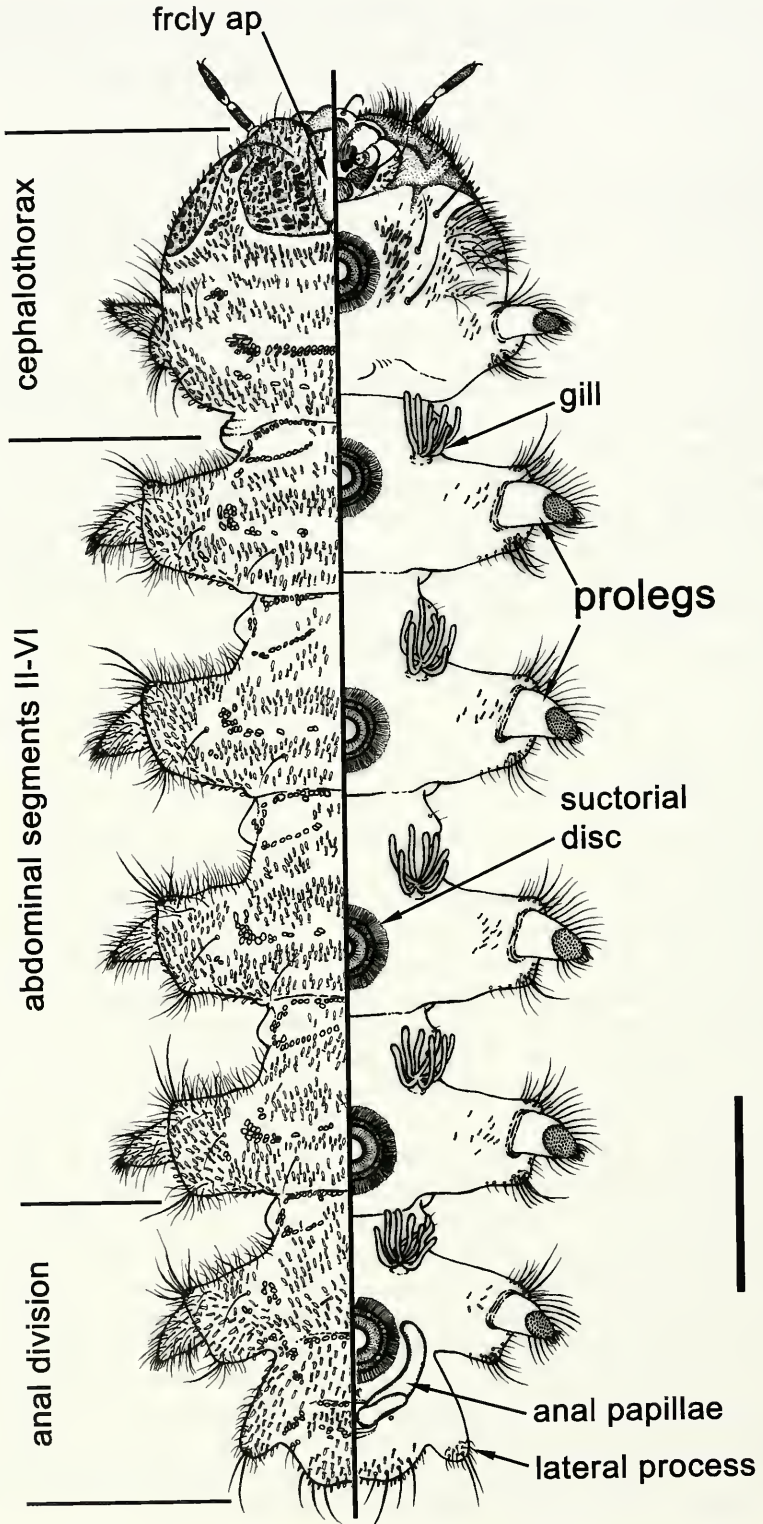


Fig. 1. *Blepharicera courtneyi* larva, dorsal (left) and ventral (right) view. Scale bar = 1 mm.

formly sclerotized and unpigmented ducts; dorsal and ventral eye divisions separated by narrow callis oculi; distal palpomere short (< 3 times length of penultimate palpomere); number of parietal sensilla 12; number of clypeal sensilla ≈ 20 .

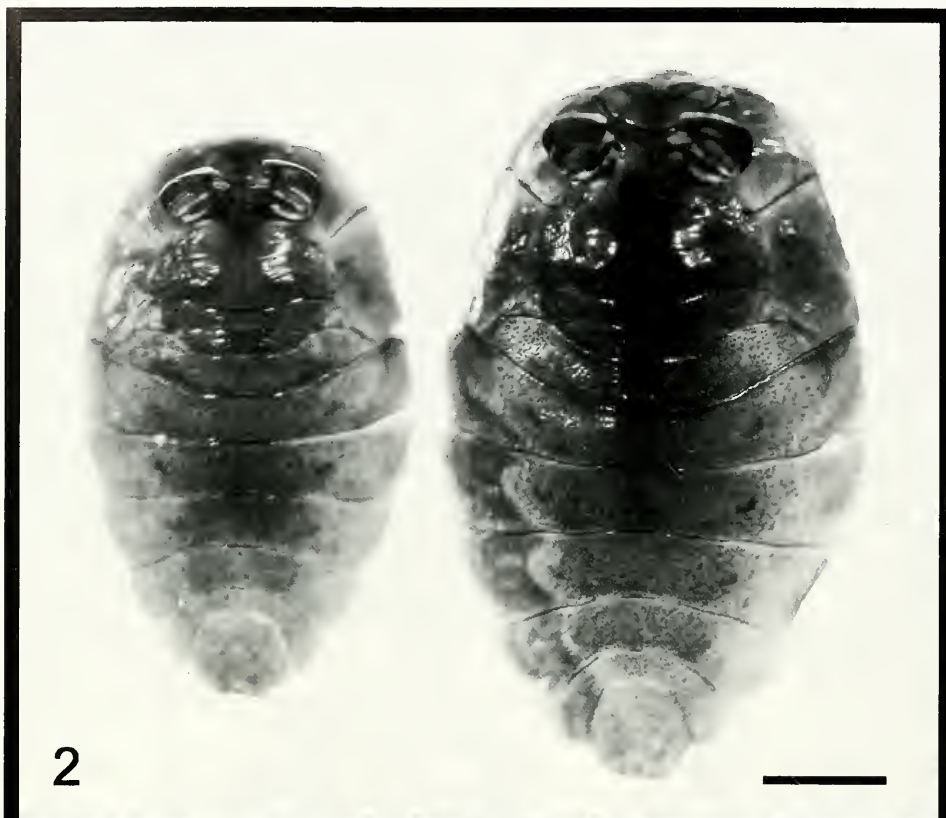
Description.—Larva (Fig. 1): Measurements, instar I ($n = 5$) total length 1.1 mm (0.9–1.4), cranial width 0.2 mm, antennal length 0.1 mm; instar II ($n = 10$) total length 2.1 mm (1.5–2.4), cranial width 0.3 mm (0.3–0.4), antennal segments: 0.02 mm, 0.1 mm; membranous region 0.02 mm; instar III ($n = 10$) total length 3.9 mm (3.0–4.8), cranial width 0.5 mm, antennal segments: 0.1 mm, 0.1 mm (0.1–0.2); membranous region 0.04 mm (0.02–0.05); instar IV ($n = 10$) total length 6.5 mm (5.4–7.9), cranial width 0.7 mm, antennal segments: 0.1 mm, 0.2 mm; membranous region 0.1 mm. Cranial sclerites light brown to brown, except interrupted by dark brown or black muscle scars; ecdysial lines with long stem line; posterior margin of frontoclypeal apotome well removed from posterior cranial margin; clypeal spines absent. Cephalic division, trunk, lateral lobes and prolegs light brown to brown. Anal division bluntly trilobed, with posterior margin slightly concave medially, never elongate; lateral process bluntly rounded apically. Chaetotaxy: Dorsal secondary sensilla fustiform, about 5–6 times length of their apical diameter; head with numerous fustiforms anteriorly and laterally, arranged in longitudinal rows between muscle scar rows dorsally; cephalic division and dorsomedial region of abdominal segments II–VI each with 4 loosely arranged transverse clusters of fustiforms; anal division covered with numerous fustiforms dorsally, not in clusters, with 4–6 prominent setiforms along apex of median lobe; lateral lobes with numerous fustiforms dorsally, few scattered fustiforms ventrally, numerous

setiforms along anterior margin and apical half of posterior margin; prolegs with numerous setiforms dorsally; substernal setae elongate digitiform, pale brown, 35–40 in number.

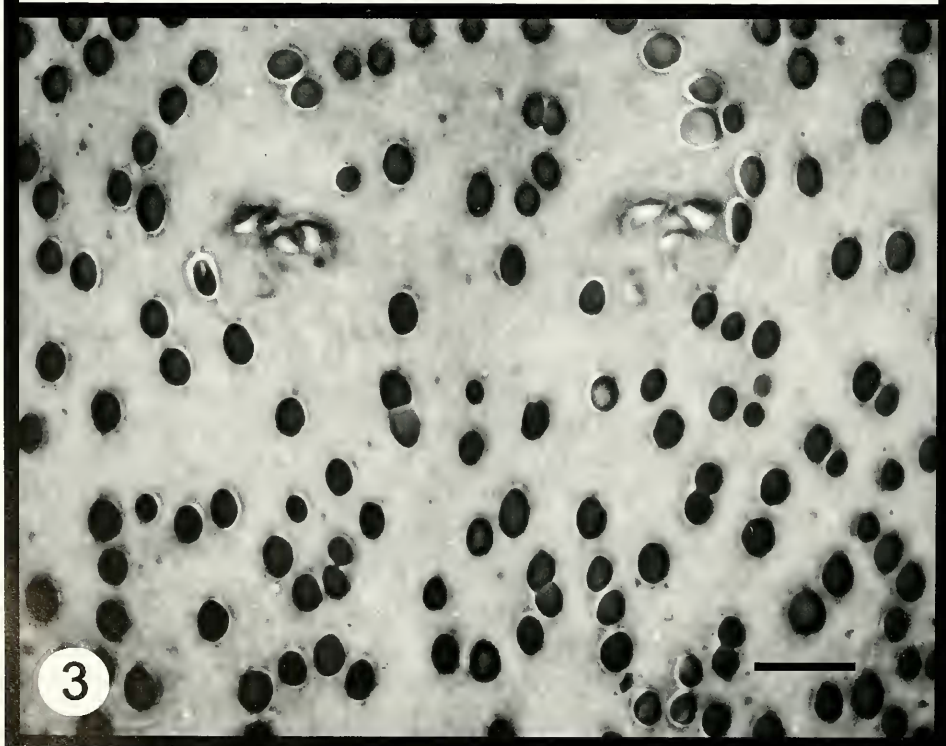
Pupa (Figs. 2–3): Measurements, male ($n = 10$) length 4.4 mm (4.1–4.6), width 2.7 (2.5–2.8); female ($n = 10$) length 5.3 (5.1–5.7), width 3.2 (3.1–3.3). Cuticle dark brown; body outline generally ovoid. Integument: Dorsal papillae present, dark, with minute spinules, irregularly distributed on abdominal segments, gaps between papillae subequal to or greater than papilla width; metatergite with numerous papillae medially, none laterally; branchial sclerite without papillae. Cuticle homogeneous, without reticulate pattern. Anal tergite not wrinkled. Respiratory lamellae dark brown to black; middle lamellae broad, width at midpoint greater than half width of outer lamellae.

Adult male: Head and terminalia only (from dissected pupae).

Head (Fig. 5): Structure: Normal type, semi-dichoptic. Clypeus length/width = 2.2. Eyes well separated dorsally, interocular distance approximately 0.1 mm; eye divided, dorsal division much smaller than and contiguous with ventral division (callis oculi absent); dorsal division with approximately 11–12 rows of ommatidia along mid-meridian; dorsal ommatidia larger in diameter than ventral ones. Length of free portion of proboscis about 0.37 times head width; mandibles absent; palpi with 5 palpomeres, distal 4 palpomere proportions 1.0–1.1–1.1–3.5. Antenna with 15 articles, flagellomeres cylindrical; length of ultimate flagellomere 1.2 times length of penultimate flagellomere; scape and pedicel with several prominent setiforms, flagellomere 1 mostly glabrous basally but setose apically, f₂–f₁₂ setose, f₁₃ setose with setae larger basally than apically, terminated in 2 prominent setiforms; scape, pedicel and flagellomeres



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brown. Chaetotaxy: Setiform groups as follows, clypeals (≈ 12), parietals (0), occipitals (≈ 24), verticals (5 or 6), postgenals (≈ 12).

Coloration: Frons and face dark brown, pruinose; clypeus brown; ocellar triangle dark brown. Thorax pruinose; mesoscutum and scutellum dark brown to brown; pleuron dark brown anteriorly, pale posteriorly. Forecoxae pale with brown patch anteriorly, other coxae pale. Abdominal tergites light brown to brown, sternites pale, pleural membrane pale.

Terminalia (Figs. 7–8): Abdominal segment VIII reduced, mostly membranous; tergite consisting of basal ligulate sclerite extended to pleural region; pleurites and sternites undifferentiated. Epanthrium simple, slightly emarginate posteromedially, bearing numerous setiform sensilla. Cerci well developed, parallel, bearing numerous setiform sensilla; interlobular depression U-shaped; individual cercal lobes elongate, medial margin convex near apex, posterior margin slightly emarginate with prominent hook arising near medial margin, posterolateral margin extended posterolaterally as a rounded lobe. Genital capsule small, slightly longer than wide. Gonostylus bearing numerous setiform sensilla. Aedeagal rods of phallus with median filament subequal in length to lateral filaments, with simple apices. Ejaculatory apodeme extended about 1/2 distance to anterior margin of lateral parameral lobes. Parameres: Dorsal paramere opaque, apex weakly to moderately emarginate on either side of medial dorsal carina; ventral parameres longer than aedeagal rods, broad throughout, tapered to complex apex with slight hook on inner wall; lateral parameral lobes

large, broad, outer margins slightly divergent and emarginate.

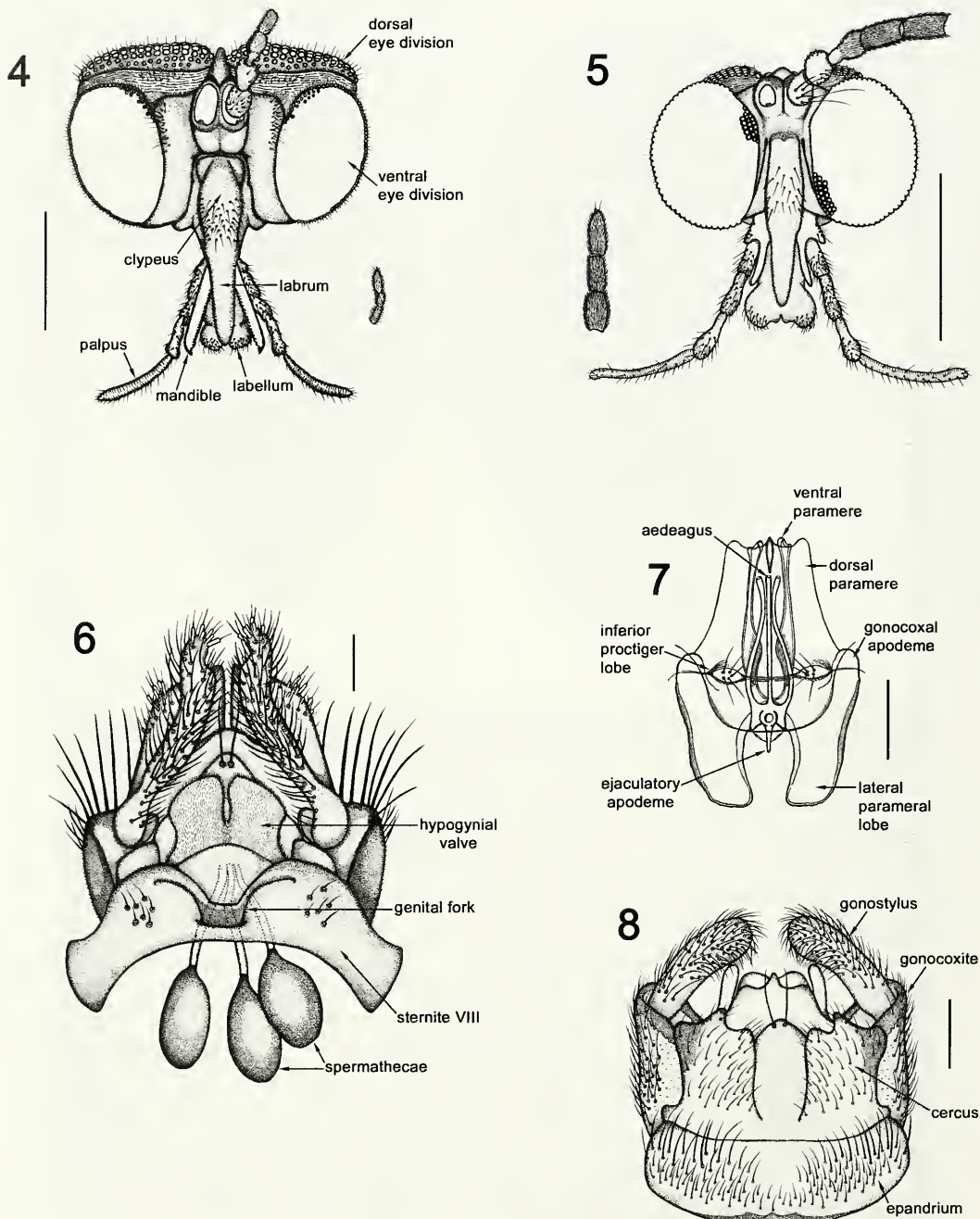
Adult female: Size: Medium. Measurements ($n = 10$): Total length 5.9 mm (5.5–6.4), wing length 6.8 mm (6.3–7.2), width 2.1 mm (1.9–2.4).

Head (Fig. 4): Structure: Normal holoptic. Clypeus length/width = 2.6. Eyes approximate dorsally, interocular distance approximately 0.04 mm (0.04–0.05); eye divided, dorsal division slightly smaller than and well differentiated from ventral division (callis oculi narrow); dorsal division with 13–14 ommatidia along mid-meridian. Length of free portion of proboscis about 0.48 times head width; mandibles present; palpus with 5 palpomeres, distal 4 palpomere proportions 1.0–1.4–1.5–3.3. Antenna with 15 articles, flagellomeres filiform; ultimate flagellomere 1.5 times length of penultimate flagellomere; scape and pedicel with several prominent setiforms, flagellomere 1 glabrous basally, setose apically, f2–f12 setose, f13 setose with 2 prominent setiforms apically; scape light brown, pedicel and base of f1 brown, remaining portion black. Chaetotaxy: Setiform groups as follows (number per side): clypeals (≈ 20), parietals (12), occipitals (≈ 14), verticals (3), postgenals (≈ 10).

Thorax and appendages: Tibial spurs 0–0–2; spurs asymmetrical, one each long (0.2 mm) and short (0.07 mm); base of hind tarsomere 1 with five or six dark, spiniform sensilla. Leg-segment lengths summarized in Table 1. Leg-segment proportions: fore—36:31:14:8:4:3:4, mid—36:30:14:8:5:3:4, hind—38:34:14:5:3:2:3. Chaetotaxy: Scutum glabrous; scutellum with cluster of 20 chaetiforms laterally and diffuse row of chaetiforms across midline.

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Figs. 2–3. Light micrographs of pupal *Blepharicera courtneyi*. 2, Habitus of male (left) and female (right), dorsal view. 3, Microsculpture, abdominal tergite V. Scale bars = 1 mm (Fig. 2), 0.05 mm (Fig. 3).



Figs. 4-8. Adults of *Blepharicera courtneyi*. 4, Female head and antennal apex, frontal view. 5, Male head and antennal apex, frontal view. 6, Female terminalia, ventral view. 7, Male terminalia (phallic structures), dorsal view. 8, Male terminalia, dorsal view. Scale bars = 0.5 mm (Figs. 4-5), 0.1 mm (Figs. 6-8).

Table 1. Lengths of leg segments of adult female *Blepharicera courtneyi*, n. sp. (n = 5). Measurements in millimeters; mean (range).

Leg-segment Lengths:	Foreleg	Midleg	Hindleg
femur	3.9 (3.6–4.2)	3.8 (3.5–4.1)	5.5 (5.1–6.0)
tibia	3.3 (3.0–3.6)	3.2 (2.9–3.5)	4.5 (4.5–5.3)
tarsus 1	1.5 (1.4–1.7)	1.5 (1.4–1.7)	2.1 (1.9–2.2)
2	0.9 (0.7–0.9)	0.8 (0.7–0.9)	0.8 (0.7–0.8)
3	0.5 (0.4–0.5)	0.5 (0.4–0.5)	0.4 (0.4–0.5)
4	0.3 (0.3–0.4)	0.3	0.3 (0.3–0.4)
5	0.4	0.4	0.4 (0.3–0.4)

Coloration: Frons and face dark brown to gray, pruinose; clypeus pruinose basally, light brown apically. Thorax pruinose; mesoscutum brown, scutellum light brown; pleuron brown to light brown anteriorly (episternum, anterior 1/2 of anepimeron), pale posteriorly. Coxae pale. Abdominal tergites brown with narrow, light brown band near posterior margin; sternites light brown, pleural membrane pale.

Terminalia (Fig. 6): Posterior margin of sternite VIII broadly bilobate, medial depression prominent, broadly U-shaped. Sternite IX (genital fork) broadly Y-shaped, with short sclerotized extensions anteriorly and laterally. Hypogynial plate broad basally, narrowed slightly to apical valves; individual valves narrow basally, slightly expanded medially, tapered to rounded apex posteriorly; inner margins of valves parallel basally, divergent posteriorly. Accessory gland narrow, elongate, and extended beyond spermathecae basally, ovoid distally. Spermathecae 3 in number; corpora ovoid, about twice as long as wide, with short necks; ducts short, uniformly sclerotized and unpigmented. Chaetotaxy: Sternite VIII with 6–7 setiforms laterally and few minute setiforms medially; hypogynial plate and valves bearing numerous minute setiforms; epiproct with two prominent setiforms apically.

Type material.—Holotype [adult female]: UNITED STATES. TENNESSEE:

Rhea Co: Piney River @ Shut-in Gap Rd., 35°42.873'N 84°52.831'W, 3 May 2006, coll. G.R. Curler and J.K. Moulton. Specimen pinned, genitalia in glycerin microvial [USNM]. Paratypes: Same locality as holotype, 12 March 2006 [10 instar IV L (EtOH), 2 instar IV L (slides)], coll. G.R. Curler and J.K. Moulton; 24 April 2006 [1 male P (slide), 4 A female (pinned), 2 A female (pinned, head and genitalia in glycerin microvials), 2 A female (slides), 6 male P, 6 female P (EtOH), 1 female P (slide)], coll. G.R. Curler and J.K. Moulton; TENNESSEE: *Cumberland Co:* Mammys Creek @ U.S. 70, 0.5 km W of Westel, 35°52.409'N 84°47.113'W, 28 March 2006 [10 instar IV L (EtOH)], coll. J.K. Moulton; 24 April 2006 [4 male P (slides)], coll. G.R. Curler and J.K. Moulton; 3 May 2006 [3 male P (slides), 6 male P, 6 female P (EtOH)], coll. G.R. Curler and J.K. Moulton; 30 April 2007 [3 male A (reared, EtOH)], coll. G.R. Curler. Holotype and most paratypes deposited in USNM; remaining paratypes deposited in UTK.

Other material examined.—UNITED STATES. TENNESSEE: *Rhea Co:* Piney River @ Shut-in Gap Rd., 35°42.873'N 84°52.831'W, 25 February 2006 [L], coll. G.R. Curler and J.K. Moulton; 12 March 2006 [L], coll. G.R. Curler and J.K. Moulton; 24 April 2006 [LPA], coll. G.R. Curler and J.K. Moulton; *Bledsoe Co:* Fall Creek Falls State Park @ Cane Creek

Cascades, 35°39.461'N 85°21.023'W, 28 March 2007 [L], coll. G.R. Curler and J.K. Moulton; *Cumberland Co.*: Mammys Creek @ U.S. 70, 0.5 km W of Westel, 35°52.409'N 84°47.113'W, 28 March 2006 [LP], coll. J.K. Moulton; 24 April 2006 [LP], coll. G.R. Curler and J.K. Moulton; 3 May 2006 [LP] coll. G.R. Curler and J.K. Moulton; *White Co.*: Caney Fork River @ Scott's Gulf Rd. 35°50'N 85°16'W, 16 March 2006 [L], coll. J.K. Moulton.

Etymology.—This species is named in honor of our colleague and noted blepharicerid systematist, Dr. Gregory W. Courtney.

Distribution.—*Blepharicera courtneyi* is known only from four sites on the Cumberland Plateau of east-central Tennessee: Piney River, Mammys Creek, Cane Creek, and Caney Fork River. Focused collecting efforts in other fast flowing streams and rivers on the Cumberland Plateau, including the Big South Fork National River and Recreation Area, during early spring should yield additional material of this species.

Bionomics.—Available records suggest this species is univoltine, with larvae first noticeable in February, and adults on the wing by early May. Fourth-instar larvae are common by mid-March and pupae are present by mid-April. Adult females were observed resting on leaf-tips of hardwoods, particularly maple-leaved viburnum, *Viburnum acerifolium* L., along a hiking trail adjacent to the Piney River at Shut-in Gap in late April and early May. Females were also taken on those same dates at a blacklight trap placed on the banks of the Piney River adjacent to a calm pool. Males have not been observed in nature.

Remarks.—All life stages after the egg most closely resemble those of *B. hispida* and *B. tenuipes*. Larvae can be distinguished by chaetotaxy: dorsum of abdominal segments with four transverse clusters of fustiform sensilla, rather than being completely covered as in *B. hispida*

or with two transverse clusters as in *B. tenuipes*. Larvae of *B. courtneyi* also differ from those of *B. hispida* by having shorter dorsal secondary sensilla (5–6 rather than 8–10 times the length of their apical diameter). Pupae appear indistinguishable from those of *B. tenuipes* and differ only slightly from pupae of *B. hispida* and *B. coweetae* Hogue and Georgian (latter two with wrinkled anal tergite and somewhat dull surface luster). A scanning electron microscopy study of *B. courtneyi* pupae may reveal additional diagnostic characters. Adult males and females can be separated from *B. hispida*, *B. tenuipes*, and other eastern Nearctic *Blepharicera* species by a combination of head and genitalic characters. Males can be separated by the following suite of characters: cercus with inner margin straight (sinuate in *B. hispida*), posterolateral margin extended into rounded lobe (truncate in *B. hispida*), and outer margin concave (straight in *B. hispida*); lateral parameral lobe elongate, twice as long as median width (as long as broad in *B. hispida*); apex of ventral paramere extended to distal 1/3 or more of apex of dorsal carina (barely reaching anterior portion of dorsal carina in *B. tenuipes*). Females can be identified by the following suite of characters: dorsal and ventral eye divisions separated by narrow callis oculi (broad in *B. tenuipes*); distal palpomere short, ca. twice length of penultimate palpomere (> 2.5 times length in *B. hispida* and *B. tenuipes*); spermatheca ovoid, ca. twice as long as broad (subspherical in *B. hispida*); number of parietal sensilla 12 (> 30 in *B. tenuipes*); number of clypeal sensilla ≈ 20 (10–15 in *B. hispida*).

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